General

Guideline Title

Energy expenditure: measuring resting metabolic rate (RMR) in the healthy and non-critically ill evidence-based nutrition practice guideline.

Bibliographic Source(s)

Academy of Nutrition and Dietetics. Energy expenditure: measuring resting metabolic rate (RMR) in the healthy and non-critically ill evidence-based nutrition practice guideline. Chicago (IL): Academy of Nutrition and Dietetics; 2014. Various p.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Ratings for the strength of the recommendations (Strong, Fair, Weak, Consensus, Insufficient Evidence), conclusion grades (I-V), and statement labels (Conditional versus Imperative) are defined at the end of the "Major Recommendations" field.

Energy Expenditure (EE): Rest Periods in Healthy and Non-Critically Ill Adults

EE: Rest Periods in Healthy and Non-Critically Ill Adults

The registered dietitian nutritionist (RDN) should aim for a 30-minute rest period before starting a measurement of resting metabolic rate (RMR) in a healthy adult or those with stable chronic obstructive pulmonary disease (COPD). If this is not possible, a 20-minute rest period may be sufficient. Research primarily in healthy adults showed that resting condition is achieved by the 30th minute of reclined rest, but studies that measured shorter rest times indicate that resting condition can occur in as little as 20 minutes in many adults. Individuals who move during the rest recovery time do not achieve a resting state by 20 minutes and may not be at complete rest at 30 minutes.

Strong, Imperative

EE: Rest Periods in Healthy Children

The RDN should aim for a 30-minute rest period before starting a measurement of RMR in a healthy child. However, if the child cannot cooperate with both a pre-measurement rest and rest during measurement, the RDN may choose to forego the pre-measurement rest period, initiate the RMR measurement immediately and then discard the first 10 minutes of data. Research in healthy children indicates that when doing so, RMR values recorded at the 20th minute of the measurement may be most indicative of rest in children. With this approach, limited evidence suggests

that data recorded after the 10th minute are not significantly different from data at 30 minutes.

Weak, Conditional

Recommendation Strength Rationale

- Conclusion statements are Grades I and III.

EE: Resting Activities in Healthy and Non-Critically Ill

EE: Resting Activities in Healthy Adults

The RDN should ensure healthy adults rest quietly and not engage in any activity during the 30-minute rest period. Some data suggest activities such as laughing, reading, or listening to music may increase RMR.

Consensus, Imperative

EE: Body Positions in Healthy and Non-Critically Ill

EE: Body Positions in Healthy and Non-Critically Ill Adults

The RDN should conduct RMR measurements in a healthy and non-critically ill adult in the supine position when possible. Research indicates that different postures affect RMR. One study of older patients measured prior to an elective thoracotomy reported that RMR was not significantly different in the 30-degree head-of-bed elevation compared to the supine position. In healthy individuals, three studies reported that sitting RMR was greater than supine RMR and standing RMR was greater than sitting RMR.

Fair, Imperative

Recommendation Strength Rationale

- Conclusion statement is Grade II.

EE: Gas Collection Devices in Healthy and Non-Critically Ill

EE: Gas Collection Devices in Healthy Adults and Children

The RDN may select any gas collection device (ventilated hood and canopy, mouthpiece and nose clip or face mask) for an RMR measurement in a healthy adult or child. Studies comparing the use of different devices are conflicting. The individual's comfort or preference should be considered when selecting a device, if possible.

Weak, Imperative

Recommendation Strength Rationale

- Conclusion statement is Grade III.

EE: Diurnal Variation in Healthy and Non-Critically Ill

EE: Diurnal Variation in Healthy Adults

The RDN may conduct a measurement of RMR at any time of day in a healthy adult, as long as resting conditions can be achieved. Limited evidence indicates that diurnal variation has minimal effect on RMR in healthy adults.

Weak, Imperative

Recommendation Strength Rationale

- Conclusion statement is Grade III.

EE: Room Conditions in Healthy and Non-Critically Ill

EE: Room Temperature in Healthy Adults

The RDN should minimize the effect of ambient temperature on RMR in a healthy adult, by keeping the room temperature between 22°C to 25°C

(72°F to 77°F) or providing a blanket during the measurement. RMR measurements conducted at room temperatures 20°C or 68°F or less were higher than those conducted at 22°C to 25°C (72°F to 77°F). The use of a blanket minimized this increase. No studies were found that evaluated the effect of increased room temperature more than 25°C or 77°F on RMR.

Fair, Imperative

EE: Noise Conditions in Healthy and Non-Critically Ill Adults and Children

The RDN should measure RMR in a healthy or non-critically ill adult or child in a quiet room. Noise could adversely affect the measurement.

Consensus, Imperative

Recommendation Strength Rationale

- Conclusion statements are Grade II and Consensus.

EE: Fasting in Healthy and Non-Critically Ill

EE: Fasting Requirements in Healthy Adults

Prior to measurement of RMR, the RDN should ensure a healthy adult has fasted at least seven hours to minimize the thermic effect of feeding (TEF). Research in healthy adults indicates that the TEF dissipates depending on the amount of calories consumed. The TEF for meals containing approximately 450 kcal to 1,500 kcal is still present at three to five hours. One study reported that the thermic effect of consuming 1,300 kcal was negligible after seven hours post-consumption.

Fair, Imperative

EE: Exceptions to Fasting Requirements in Healthy Adults

If a seven-hour fast is not clinically feasible prior to measurement of RMR in a healthy adult, the RDN should instruct the individual that a small meal (300 kcal or less) may be consumed four hours prior to the measurement. One study reported that the TEF, when consuming approximately 300 kcal, was negligible after 3.5 hours post-consumption in healthy adults.

Fair, Conditional

Recommendation Strength Rationale

- Conclusion statement is Grade III.

EE: Caffeine and Stimulants in Healthy and Non-Critically Ill

EE: Caffeine and Stimulants in Healthy Adults

The RDN should ensure that a healthy adult refrains from ingesting caffeine or other stimulants for at least four hours prior to an RMR measurement. Ingestion of caffeine and other stimulants in healthy adults increases RMR for longer than four hours.

Fair, Imperative

Recommendation Strength Rationale

- Conclusion statement is Grade III.

EE: Smoking and Nicotine in Healthy and Non-Critically Ill

EE: Smoking and Nicotine in Healthy Adults

If a healthy adult uses nicotine products, the RDN should ask the individual to abstain from such products for longer than 140 minutes prior to an RMR measurement. Limited research in healthy adult cigarette smokers indicates that there is a significant acute increase in RMR for at least 140 minutes after smoking. No studies evaluated the use of other nicotine-containing products.

Weak, Conditional

Recommendation Strength Rationale

- Conclusion statement is Grade III.

EE: Physical Activity in Healthy and Non-Critically Ill

EE: Very Light Intensity Physical Activity in Healthy Adults

If a healthy adult engages in very light intensity physical activity (e.g., getting dressed, driving, walking less than five minutes, etc.) prior to an RMR measurement, the RDN should ensure a 30-minute rest period prior to the RMR measurement. Limited evidence in healthy adults reported that 30 minutes of rest is required for RMR to return to baseline after minimal activity.

Weak, Conditional

EE: Light to Vigorous Intensity Physical Activity in Healthy Adults

If a healthy adult engages in light to vigorous intensity physical activity, the RDN should instruct the individual to refrain from physical activity prior to the RMR measurement for a period of time (e.g., 12 to 48 hours for moderate to vigorous physical activity). Physical activity raises the RMR for an unknown period of time in healthy adults after cessation of physical activity. The elevation of metabolic rate will vary based on intensity, type, duration, level of fitness and other factors. Therefore, the length of time that the individual must refrain from physical activity should be determined based on these factors.

Consensus, Conditional

Recommendation Strength Rationale

- Conclusion statements are Grade III and Consensus.

EE: Duration of Measurement (Steady State) in Healthy and Non-Critically Ill

EE: Duration of Measurement (Steady State) in Healthy and Non-Critically Ill Adults

When measuring RMR in a healthy or non-critically ill adult, the RDN should discard the data for the first five minutes, and then use a validated steady state definition to determine the duration of the remainder of the measurement. The purpose of the discard period and steady state requirement is to minimize artifact in the measurement. Steady-state definitions vary by measurement length (four to 25 minutes), coefficient of variation (less than 5% to 10%) and combination of gas exchange variables (oxygen uptake [VO_2], carbon dioxide production [VCO_2], respiratory quotient [RQ], minute ventilation).

Weak, Conditional

EE: Duration of Measurement (Steady State) in Healthy Children

When measuring RMR in a healthy child who is unable to rest, the RDN should include the rest period in the measurement, discard the first 10 minutes of data and then continue measurement until a steady state is achieved. With this approach, limited evidence in healthy children suggests that data recorded after the 10th minute are not significantly different from data at 30 minutes; data averaged around the 20th minute have the least variability.

Weak, Conditional

Recommendation Strength Rationale

- Conclusion statements are Grades II and III.

EE: Respiratory Quotient (RQ) in Healthy and Non-Critically Ill

EE: RQ below 0.67 or Above 1.3 in Healthy Adults

If the RQ falls outside the physiologic range (below 0.67 or above 1.3) in a healthy adult, the RDN should suspect an error and repeat the RMR measurement. The physiologic range of RQ reflecting cellular metabolism across the fed and fasted state is 0.67 to 1.3.

Consensus, Conditional

EE: RQ between 0.67 and 0.90 in Healthy Adults

If the RQ falls between 0.67 and 0.90 in a healthy adult, the RDN should accept the measurement because RQ values within this range cannot

reliably be used to detect feeding protocol violations. RQ varies among healthy adults and the range of RQ between fed and fasted states overlaps. In individuals who fasted seven to 14 hours, research reports that RQ ranged from 0.68 to 0.90. Yet, in individuals who consumed a meal 2.5 hours prior to measurement, fasting RQ (0.79 to 0.81) increased by only 0.03 to 0.05. Research demonstrates that RQ has poor accuracy to evaluate feeding protocol violations.

Fair, Imperative

EE: RQ between 0.91 and 1.3 in Healthy Adults

If the RQ is between 0.91 and 1.3 in a healthy adult who has fasted, the RDN should suspect a problem and consider repeating the measurement. An RQ between 0.91 and 1.3 could be observed in an individual who has not fasted. However, it could also be due to an error in calibration, a leak in the calorimeter, a ventilation problem or some other artifact or protocol violation.

Consensus, Conditional

Recommendation Strength Rationale

- Conclusion statements are Grade II and Consensus.

Definitions:

Conditional vs Imperative Recommendations

Recommendations are categorized in terms of either *conditional* or *imperative* statements. While conditional statements clearly define a specific situation, imperative statements are broadly applicable to the target population and do not impose restraints on their application.

Conditional recommendations are presented in an if/then format, such that:

If CONDITION then ACTION(S) because REASON(S)

Fulfillment of the condition triggers one or more guideline-specified actions. In contrast, imperative recommendations include terms such as "require," "must," and "should," and do not contain conditional text that would limit their applicability to specified circumstances.

Conclusion Grading Table

Strength of Evidence Elements	Grades				
	I Good/Strong	II Fair	III Limited	IV Expert Opinion Only	V Grade Not Assignable
Quality • Scientific rigor/validity • Considers design and execution	Studies of strong design for question Free from design flaws, bias and execution problems	Studies of strong design for question with minor methodological concerns OR Only studies of weaker study design for question	Studies of weak design for answering the question OR Inconclusive findings due to design flaws, bias or execution problems	No studies available Conclusion based on usual practice, expert consensus, clinical experience, opinion, or extrapolation from basic research	No evidence that pertains to question being addressed
Consistency Of findings across studies	Findings generally consistent in direction and size of effect or degree of association, and statistical significance with	Inconsistency among results of studies with strong design	Unexplained inconsistency among results from different studies	Conclusion supported solely by statements of informed nutrition or medical commentators	NA

Strength of Evidence Elements	Grades I Good/Strong	OR II Fair	OR III Limited	IV Expert Opinion Only	V Grade Not Assignable
	minor exceptions at most	Consistency with minor exceptions across studies of weaker designs	Single study unconfirmed by other studies		
Quantity • Number of studies • Number of subjects in studies	One to several good quality studies Large number of subjects studied Studies with negative results having sufficiently large sample size for adequate statistical power	Several studies by independent investigators Doubts about adequacy of sample size to avoid Type I and Type II error	Limited number of studies Low number of subjects studied and/or inadequate sample size within studies	Unsubstantiated by published studies	Relevant studies have not been done
Clinical Impact • Importance of studied outcomes • Magnitude of effect	Studied outcome relates directly to the question Size of effect is clinically meaningful Significant (statistical) difference is large	Some doubt about the statistical or clinical significance of effect	Studied outcome is an intermediate outcome or surrogate for the true outcome of interest OR Size of effect is small or lacks statistical and/or clinical significance	Objective data unavailable	Indicates area for future research
Generalizability To population of interest	Studied population, intervention and outcomes are free from serious doubts about generalizability	Minor doubts about generalizability	Serious doubts about generalizability due to narrow or different study population, intervention or outcomes studied	Generalizability limited to scope of experience	NA

This grading system was based on the grading system from Greer, Mosser, Logan, & Wagstrom Halaas. A practical approach to evidence grading. Jt Comm J Qual Improv. 2000;26:700-712. In September 2004, The ADA Research Committee modified the grading system to this current version.

Criteria for Recommendation Rating

Statement Rating	Definition	Implication for Practice
Strong	A Strong recommendation means that the workgroup believes that the benefits of the recommended approach clearly exceed the harms (or that the harms clearly exceed the benefits in the case of a strong negative recommendation), and that the quality of the supporting evidence is excellent/good (grade I or II).* In some clearly identified circumstances, strong recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.	Practitioners should follow a Strong recommendation unless a clear and compelling rationale for an alternative approach is present.

Statement Rating	Definition	Implication for Practice
Fair	A Fair recommendation means that the workgroup believes that the benefits exceed the harms (or that the harms clearly exceed the benefits in the case of a negative recommendation), but the quality of evidence is not as strong (grade II or III).* In some clearly identified circumstances, recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits outweigh the harms.	Practitioners should generally follow a Fair recommendation but remain alert to new information and be sensitive to patient preferences.
Weak	A Weak recommendation means that the quality of evidence that exists is suspect or that well-done studies (grade I, II, or III)* show little clear advantage to one approach versus another.	Practitioners should be cautious in deciding whether to follow a recommendation classified as Weak, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.
Consensus	A Consensus recommendation means that Expert opinion (grade IV)* supports the guideline recommendation even though the available scientific evidence did not present consistent results, or controlled trials were lacking.	Practitioners should be flexible in deciding whether to follow a recommendation classified as Consensus, although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.
Insufficient Evidence	An Insufficient Evidence recommendation means that there is both a lack of pertinent evidence (grade V)* and/or an unclear balance between benefits and harms.	Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as Insufficient Evidence and should exercise judgment and be alert to emerging publications that report evidence that clarifies the balance of benefit versus harm. Patient preference should have a substantial influencing role.

*Conclusion statements are assigned a grade based on the strength of the evidence. Grade I is good; grade II, fair; grade III, limited; grade IV signifies expert opinion only and grade V indicates that a grade is not assignable because there is no evidence to support or refute the conclusion. The evidence and these grades are considered when assigning a rating (Strong, Fair, Weak, Consensus, Insufficient Evidence - see chart above) to a recommendation.

Adapted by the Academy of Nutrition and Dietetics (AND) from the American Academy of Pediatrics, Classifying Recommendations for Clinical Practice Guideline, Pediatrics. 2004;114;874-877. Revised by the AND Evidence-Based Practice Committee, Feb 2006.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

- General health
- Non-critical illnesses

Guideline Category

Evaluation

Technology Assessment

Clinical Specialty

Family Practice

Internal Medicine

Nutrition

Intended Users

Advanced Practice Nurses

Allied Health Personnel

Dietitians

Nurses

Physician Assistants

Physicians

Respiratory Care Practitioners

Students

Guideline Objective(s)

Overall Objective

To help the practitioner identify the conditions under which she/he can perform an indirect calorimetry measurement to accurately measure resting metabolic rate (RMR) in healthy and non-critically ill individuals and properly interpret the results

Specific Objectives

- To define evidence-based recommendations for the measurement of RMR, using indirect calorimetry by registered dietitian nutritionists (RDNs) in collaboration with other healthcare providers
- To guide practice decisions that integrate medical and nutritional elements
- To reduce variations in measurement practices among RDNs
- To provide the RDN with evidence-based practice recommendations to adjust the medical nutrition therapy (MNT) or recommend other therapies to achieve positive outcomes
- To promote optimal nutrition within cost constraints of the healthcare environment

Target Population

Healthy children (2 to 18 years) and healthy and non-critically ill adults (19 to 79 years)

Note: The majority of studies used in the development of this guideline were conducted on healthy adults. A few of the recommendations also included one study conducted on healthy children (age 7 to 12 years) and four studies of adults with chronic disease, but who were not critically ill. Adult subjects in the non-critically ill population included patients with chronic obstructive pulmonary disease (COPD), stable hospitalized patients (mostly fractures), individuals undergoing an elective thoracotomy, and stable cancer patients. There were no studies of non-critically ill children included.

Interventions and Practices Considered

1. Indirect calorimetry measurement of resting metabolic rate (RMR)
2. Ensuring a rest period of at least 20-30 minutes before starting RMR measurement
3. Conducting RMR measurements in supine position
4. Selection of gas collection device (ventilated hood and canopy, mouthpiece and nose clip or face mask) for RMR measurement
5. Consideration of diurnal variation (time of day) in RMR measurement
6. Ensuring RMR is measured in a quiet, thermoneutral environment
7. Fasting requirements and fasting exceptions prior to RMR measurement
8. Abstention from caffeine, stimulants, and use of nicotine products prior to RMR measurement
9. Refraining from light to vigorous physical activity prior to RMR measurement
10. Achieving a steady state in indirect calorimetry measurements (duration of measurements)
11. Application of respiratory quotient (RQ)

Major Outcomes Considered

- Resting metabolic rate (RMR) measurements related to different types of gas collection devices
- RMR measurements related to the effects of different body positions
- Effect of diurnal variation on RMR
- Room conditions
- Thermic effect of food
- Effect of caffeine and other stimulants on RMR
- Effect of physical activity
- RMR measurement lengths

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

General Methods for Collecting/Selecting the Evidence

The following list provides an overview of the steps which the Academy evidence analysis team goes through to identify research through database searches.

1. Plan the search strategy to identify the current best evidence relevant to the question. The plan for identification and inclusion of articles and reports should be systematic and reproducible, not haphazard. Write out the original search strategy and document adjustments to the strategy if they occur. Allow for several iterations of searches.
    - List inclusion and exclusion criteria. The work group will define the inclusion and exclusion criteria. These criteria will be used in defining the search strategy and for filtering the identified research reports. The Academy uses only peer-reviewed research; that is, articles accepted for evidence analysis must be peer-reviewed and published in a juried publication. Additionally, the Academy only uses human subjects in its research and does not include animal studies in its evidence analysis.
    - Identify search words. During the process of considering outcomes, interventions, nutrition diagnoses, and assessments, the work group may have identified a number of specific terms or factors that were important, but were not included in the actual question. These terms can be used as additional search terms to help identify relevant pieces of research. Both text word search and keyword search using Medical Subject Headings (MeSH) definitions may be used.
    - Identify databases to search. PubMed, Medline, CINAHL, EMBASE, Cochrane, Agricola, DARE, TRIP, AHRQ and ERIC are some common databases for clinical nutritional research. Note that search terms can vary depending on the database.

2. Conduct the search. Depending on the number and type of sources found in the initial search, adjustments might have to be made in the search strategy and to inclusion/exclusion criteria, and additional searches run. Changes to the search plan should be recorded for future reference. Document the number of sources identified in each search.
3. Review titles and abstracts. At this point, a filtering procedure is used to determine whether a research article matches the inclusion criteria and is relevant to the work group's questions. Typically, the lead analyst, along with a member of the expert workgroup, first reviews the citations and abstracts to filter out reports that are not applicable to the question. If a determination cannot be made based on the citation and abstract, then the full text of the article is obtained for review.
4. Gather all remaining articles and reports. Obtain paper or electronic copies of research articles that remain on the list following the citation and abstract review. If there are less than six citations, it could mean that the search was too specific to identify relevant research or that research has not been done on this topic. A broadened search should be tried. When there is a long list of citations, ascertain whether it includes articles that are tangential to the question or address the question in only a general way. In this case a more focused search strategy may be necessary.

Specific Methods for This Guideline

The recommendations in the guideline were based on a systematic review of the literature. Searches of Ovid MEDLINE were performed on the following topics involving both healthy and non-critically ill populations:

- Rest period duration
- Resting activities
- Body positions
- Gas collection devices
- Diurnal variation (time of day)
- Room conditions
- Fasting requirements
- Caffeine and stimulants
- Smoking and nicotine
- Physical activity
- Duration of measurement (steady state)
- Application of Respiratory Quotient (RQ)

Each evidence analysis topic has a link to supporting evidence, where the Search Plan and Results can be found. Here, the reader can view when the search plan was performed, inclusion and exclusion criteria, search terms, databases that were searched and the excluded articles.

Number of Source Documents

The total number of supporting documents for all of the reviewed topics is below:

- Recommendations: 19
- Conclusion Statements: 19
- Evidence Summaries: 13
- Article Worksheets: 44

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Conclusion Grading Table

Strength of Evidence Elements	Grades				
	I Good/Strong	II Fair	III Limited	IV Expert Opinion Only	V Grade Not Assignable
Quality • Scientific rigor/validity • Considers design and execution	Studies of strong design for question Free from design flaws, bias and execution problems	Studies of strong design for question with minor methodological concerns OR Only studies of weaker study design for question	Studies of weak design for answering the question OR Inconclusive findings due to design flaws, bias or execution problems	No studies available Conclusion based on usual practice, expert consensus, clinical experience, opinion, or extrapolation from basic research	No evidence that pertains to question being addressed
Consistency Of findings across studies	Findings generally consistent in direction and size of effect or degree of association, and statistical significance with minor exceptions at most	Inconsistency among results of studies with strong design OR Consistency with minor exceptions across studies of weaker designs	Unexplained inconsistency among results from different studies OR Single study unconfirmed by other studies	Conclusion supported solely by statements of informed nutrition or medical commentators	NA
Quantity • Number of studies • Number of subjects in studies	One to several good quality studies Large number of subjects studied Studies with negative results having sufficiently large sample size for adequate statistical power	Several studies by independent investigators Doubts about adequacy of sample size to avoid Type I and Type II error	Limited number of studies Low number of subjects studied and/or inadequate sample size within studies	Unsubstantiated by published studies	Relevant studies have not been done
Clinical Impact • Importance of studied outcomes • Magnitude of effect	Studied outcome relates directly to the question Size of effect is clinically meaningful Significant (statistical) difference is large	Some doubt about the statistical or clinical significance of effect	Studied outcome is an intermediate outcome or surrogate for the true outcome of interest OR Size of effect is small or lacks statistical and/or	Objective data unavailable	Indicates area for future research

Strength of Generalizability Evidence Elements	Grades		clinical significance		
To population of interest	I Good/Strong Studied population, intervention and outcomes are free from serious doubts about generalizability	II Fair Minor doubts about generalizability	III Limited Serious doubts about generalizability due to narrow or different study population, intervention or outcomes studied	IV Expert Opinion Only Generalizability limited to scope of experience	V Grade Not Assignable NA

This grading system was based on the grading system from Greer, Mosser, Logan, & Wagstrom Halaas. A practical approach to evidence grading. Jt Comm J Qual Improv. 2000;26:700-712. In September 2004, The ADA Research Committee modified the grading system to this current version.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Step 1: Formulate Evidence Analysis Question

Specify a question in a defined area of practice or state a tentative conclusion or recommendation that is being considered. Include the patient type and special needs of the target population involved, the alternatives under consideration, and the outcomes of interest (PICO format).

Step 2: Gather and Classify Evidence

Conduct a systematic search of the literature to find evidence related to the question, gather studies and reports, and classify them by type of evidence. Classes differentiate primary reports of new data according to study design, and distinguish them from secondary reports that include systematic and/or narrative review.

Step 3: Critically Appraise Each Article

Review each article for relevance to the question and use the checklist of questions to evaluate the research design and implementation. Abstract key information from the report.

Step 4: Summarize Evidence

Synthesize the reports into an overview table and summarize the research relevant to the question.

Step 5: Write and Grade the Conclusion Statement

Develop a concise conclusion statement (the answer to the question). Assign a grade to indicate the overall strength or weakness of evidence informing the conclusion statement (see the "Rating Scheme for the Strength of the Evidence" field).

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Development of Evidence-Based Nutrition Practice Guidelines

The expert work group, which includes practitioners and researchers with a depth of experience in the specific field of interest, develops the disease-specific guideline. The guideline development involves the following steps:

1. Review the Conclusion Statements: The work group meets to review the materials resulting from the evidence analysis, which may include

conclusion statements, evidence summaries, and evidence worksheets.

2. Formulate Recommendations for the Guideline Integrating Conclusions from Evidence Analysis: The work group uses an expert consensus method to formulate the guideline recommendations and complete the various sections on the recommendation page. These include:
    - Recommendation(s): This is a course of action for the practitioner. The recommendation is written using two brief and separate statements. The first statement is "what" the dietitian should do or not do. The second statement describes the "why" of the recommendation. More than one recommendation may be formulated depending on a particular topic and the supporting conclusion statements.
    - Rating: The rating for the recommendation is based on the strength of the supporting evidence. The grade of the supporting conclusion statement(s) will help determine this rating (see the "Rating Scheme for the Strength of the Recommendations" field).
    - Label of Conditional or Imperative: Each recommendation will have a label of "conditional" or "imperative." Conditional statements clearly define a specific situation, while imperative statements are broadly applicable to the target population without restraints on their pertinence.
    - Risks and Harms of Implementing the Recommendations: Includes any potential risks, anticipated harms or adverse consequences associated with applying the recommendation(s) to the target population.
    - Conditions of Application: Includes any organizational barriers or changes that would need to be made within an organization to apply the recommendation in daily practice. Also includes any conditions which may limit the application of the recommendation(s). For instance, application may be limited to only people in an inpatient setting, or not applicable for pregnant women. Facilitators for the application of the guideline may also be listed here. Conditional recommendations will always have conditions specified. Imperative recommendations may have some general conditions for application.
    - Potential Costs Associated with Application: Includes any costs that may be associated with the application of this recommendation such as specialized staff, new equipment or treatments.
    - Recommendation Narrative: Provides a brief description of the evidence that supports this recommendation.
    - Recommendation Strength Rationale: Provides a brief list of the evidence strength and methodological issues that determined the recommendation strength.
    - Minority Opinions: If the expert work group cannot reach consensus on the recommendation, the minority opinions may be listed here.
    - Supporting Evidence: Provides links to the conclusions statements, evidence summaries and worksheets related to the formulation of this recommendation(s).
3. References Not Graded in the Academy's Evidence Analysis Process: Recommendations are based on the summarized evidence from the analysis. Sources that are not analyzed during the evidence analysis process may be used to support and formulate the recommendation or to support information under other categories on the recommendation page, if the workgroup deems necessary. References must be credible resources (e.g., consensus reports, other guidelines, position papers, standards of practice, articles from peer-reviewed journals, nationally recognized documents or websites). If recommendations are based solely on these types of references, they will be rated as "consensus." Occasionally recommendations will include references that were not reviewed during the evidence analysis process but are relevant to the recommendation, risks and harms of implementing the recommendation, conditions of application, or potential costs associated with application. These references will be listed on the recommendation page under "References Not Graded in the Academy's Evidence Analysis Process."
4. Develop a Clinical Algorithm for The Guideline: The workgroup develops a clinical algorithm based on Academy's Nutrition Care Process, to display how each recommendation can be used within the treatment process and how they relate to the Nutrition Assessment, Diagnosis, Intervention and Monitoring and Evaluation.
5. Complete the Writing of the Guideline: Each disease-specific guideline has a similar format which incorporates the Introduction (includes: Scope of the Guideline, Statement of Intent, Guideline Methods, Implementation, Benefits and Risks/Harms of Implementation), Background Information and any necessary Appendices. The work group develops these features.
6. Criteria Used in Guideline Development: The criteria used in determining the format and process for development of Academy's guidelines are based on the following tools and criteria for evidence-based guidelines:
    - Guideline Elements Model (GEM) which has been incorporated by the American Society for Testing and Materials (ASTM) as a Standard Specification for clinical practice guidelines.
    - Appraisal for Guidelines Research and Evaluation (AGREE) Instrument
    - National Guideline Clearinghouse www.guideline.gov .

Rating Scheme for the Strength of the Recommendations

Criteria for Recommendation Rating

Statement Rating	Definition	Implication for Practice
Strong	A Strong recommendation means that the workgroup believes that the benefits of the recommended approach clearly exceed the harms (or that the harms clearly exceed the benefits in the case of a strong negative recommendation), and that the quality of the supporting evidence is excellent/good (grade I or II).* In some clearly identified circumstances, strong recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.	Practitioners should follow a Strong recommendation unless a clear and compelling rationale for an alternative approach is present.
Fair	A Fair recommendation means that the workgroup believes that the benefits exceed the harms (or that the harms clearly exceed the benefits in the case of a negative recommendation), but the quality of evidence is not as strong (grade II or III).* In some clearly identified circumstances, recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits outweigh the harms.	Practitioners should generally follow a Fair recommendation but remain alert to new information and be sensitive to patient preferences.
Weak	A Weak recommendation means that the quality of evidence that exists is suspect or that well-done studies (grade I, II, or III)* show little clear advantage to one approach versus another.	Practitioners should be cautious in deciding whether to follow a recommendation classified as Weak, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.
Consensus	A Consensus recommendation means that Expert opinion (grade IV)* supports the guideline recommendation even though the available scientific evidence did not present consistent results, or controlled trials were lacking.	Practitioners should be flexible in deciding whether to follow a recommendation classified as Consensus, although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.
Insufficient Evidence	An Insufficient Evidence recommendation means that there is both a lack of pertinent evidence (grade V)* and/or an unclear balance between benefits and harms.	Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as Insufficient Evidence and should exercise judgment and be alert to emerging publications that report evidence that clarifies the balance of benefit versus harm. Patient preference should have a substantial influencing role.

*Conclusion statements are assigned a grade based on the strength of the evidence. Grade I is good; grade II, fair; grade III, limited; grade IV signifies expert opinion only and grade V indicates that a grade is not assignable because there is no evidence to support or refute the conclusion. The evidence and these grades are considered when assigning a rating (Strong, Fair, Weak, Consensus, Insufficient Evidence - see chart above) to a recommendation.

Adapted by the Academy of Nutrition and Dietetics (AND) from the American Academy of Pediatrics, Classifying Recommendations for Clinical Practice Guideline, Pediatrics. 2004;114;874-877. Revised by the AND Evidence-Based Practice Committee, Feb 2006.

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

Each guideline is reviewed internally and externally using the Appraisal for Guidelines Research and Evaluation (AGREE) Instrument as the evaluation tool. The external reviewers consist of an interdisciplinary group of individuals (may include dietitians, doctors, psychologists, nurses, etc.). The guideline is adjusted by consensus of the expert panel and approved by Academy's Evidence-Based Practice Committee prior to publication on the Evidence Analysis Library (EAL).

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

The guideline contains conclusion statements that are supported by evidence summaries and evidence worksheets. These resources summarize the important studies (randomized controlled trials [RCTs], clinical studies, observational studies, cohort and case-control studies) pertaining to the conclusion statement and provide the study details.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

The primary goal of implementing these recommendations includes improving the percentage of individuals who are able to meet their nutritional needs and positively impact the patient's treatment and clinical outcomes.

Potential Harms

Overall Risk/Harm Considerations

- Safety issues should be considered for each recommendation.
- Failure to measure the resting metabolic rate (RMR) accurately may result in incorrect diagnosis of the energy state, inaccurate therapy for patients who want to gain or lose body weight, or overfeeding or underfeeding of healthy and non-critically ill individuals.
- Not following the guideline may result in inappropriate nutrition care plans, due to inaccurate RMR measurement.
- When applying the recommendation to children, the child's age should be considered, due to variability in physical and developmental attributes.
- Clinical judgment should be used in applying these recommendations to individuals other than the populations specified in each recommendation, since limited evidence exists in children and across the spectrum of healthy and non-critically ill adults.

Technical Factors That Decrease the Accuracy of Indirect Calorimetry Measurements

- Mechanical ventilation with fraction of inspired oxygen (FIO_2) ≥60%
- Mechanical ventilation with positive end-expiratory pressure (PEEP) >12 cm H_2O
- Hyperventilation or hypoventilation
- Sampling system leak
- Excessive moisture in the indirect calorimetry system
- Failure to collect all expiratory flow (e.g., bronchopleural fistula, chest tube leak, etc.)
- Supplemental oxygen in spontaneously breathing patients
- Hemodialysis in progress
- Calibration errors

See also "Factors to Consider Before, During and After an RMR Measurement" in the "Benefits and Risks/Harms of Implementing the Recommendations" section of the original guideline document.

Recommendation-Specific Risks/Harms

Caffeine and Stimulants in Healthy Adults

A four-hour abstinence from caffeine or other stimulants may be difficult for some individuals.

Smoking and Nicotine in Healthy Adults

Abstaining from nicotine products for more than 140 minutes may be difficult for some individuals.

Contraindications

Contraindications

Clinical judgment is needed to determine if fasting is contraindicated.

Qualifying Statements

Qualifying Statements

- This nutrition practice guideline is meant to serve as a general framework for handling clients with particular health problems. The independent skill and judgment of the health care provider must always dictate treatment decisions.
- While evidence-based nutrition practice guidelines represent a statement of best practice based on the latest available evidence at the time of publishing, they are not intended to overrule professional judgment. Rather, they may be viewed as a relative constraint on individual clinician discretion in a particular clinical circumstance. These nutrition practice guidelines are provided with the express understanding that they do not establish or specify particular standards of care, whether legal, medical or other.
- This guideline recognizes the role of patient preferences for possible outcomes of care, when the appropriateness of a clinical intervention involves a substantial element of personal choice or values. With regard to types of evidence that are associated with particular outcomes, two major classes have been described. Patient-oriented evidence that matters (POEM) deals with outcomes of importance to patients, such as changes in morbidity, mortality or quality of life. Disease-oriented evidence (DOE) deals with surrogate end-points, such as changes in laboratory values or other measures of response. Although the results of DOE sometimes parallel the results of POEM, they do not always correspond. When possible, the Academy of Nutrition and Dietetics recommends using POEM-type evidence rather than DOE. When DOE is the only guidance available, the guideline indicates that key clinical recommendations lack the support of outcomes evidence.

Implementation of the Guideline

Description of Implementation Strategy

The publication of this guideline is an integral part of the plans for getting the Academy of Nutrition and Dietetics evidence-based recommendations on Measuring Resting Metabolic Rate (RMR) in the Healthy and Non-Critically Ill to all dietetics practitioners engaged in, teaching about or researching critical illness as quickly as possible. National implementation workshops at various sites around the country and during the Academy Food Nutrition Conference Expo (FNCE) are planned. Additionally, there are recommended dissemination and adoption strategies for local use of the Academy's Measuring RMR in the Healthy and Non-Critically Ill Evidence-Based Nutrition Practice Guideline.

The guideline development team recommended multi-faceted strategies to disseminate the guideline and encourage its implementation. Management support and learning through social influence are likely to be effective in implementing guidelines in dietetic practice. However, additional interventions may be needed to achieve real change in practice routines.

Implementation of the Measuring RMR in the Healthy and Non-Critically Ill Evidence-Based Nutrition Practice Guideline will be achieved by announcement at professional events, presentations and training.

Some strategies include:

- National and local events: State dietetic association meetings and media coverage will help launch the guideline.
- Local feedback adaptation: Presentation by members of the work group at peer review meetings and opportunities for continuing education units (CEUs) for courses completed.
- Education initiatives: The guideline and supplementary resources will be freely available for use in the education and training of dietetic interns and students in approved Accreditation Council for Education in Nutrition and Dietetics (ACEND) programs.
- Champions: Local champions will be identified and expert members of the guideline team will prepare articles for publications. Resources will be provided that include PowerPoint presentations, full guidelines and pre-prepared case studies.
- Practical tools: Some of the tools that will be developed to help implement the guideline include specially designed resources such as clinical algorithms, a toolkit, and a slide presentation.

Specific distribution strategies include:

Publication in full: The guideline will be available electronically at the Academy Evidence Analysis Library Web site and will be announced to all Academy Dietetic Practice Groups. The Academy Evidence Analysis Library will also provide downloadable supporting information.

Implementation Tools

Quick Reference Guides/Physician Guides

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Staying Healthy

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Academy of Nutrition and Dietetics. Energy expenditure: measuring resting metabolic rate (RMR) in the healthy and non-critically ill evidence-based nutrition practice guideline. Chicago (IL): Academy of Nutrition and Dietetics; 2014. Various p.

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2014

Guideline Developer(s)

Academy of Nutrition and Dietetics - Professional Association

Source(s) of Funding

Academy of Nutrition and Dietetics

Guideline Committee

Energy Expenditure: Measuring Resting Metabolic Rate (RMR) in the Healthy and Non-critically Ill Evidence-Based Nutrition Practice Guideline Expert Workgroup

Composition of Group That Authored the Guideline

Expert Workgroup Members: Sue Davies, PhD, DCN, MPH, RD (*Chair*); Carrie Earthman, PhD, RD; David Frankenfield, MS, RD, CNSD; Susan Fullmer, PhD, RD, CD; Abigail Coleman, MS, RD, CNSD (resigned December 2011); Peggy Lee, MSc, RD, CNSC (joined June 2012); Kate Wilcutts, MS, RD, CNSD (resigned September 2012); Jillian Trabulsi, PhD, RD (joined September 2012)

Financial Disclosures/Conflicts of Interest

Disclosures of Potential Conflicts of Interest: In the interest of full disclosure, the Academy has adopted the policy of revealing relationships workgroup members have with companies that sell products or services that are relevant to this topic. Workgroup members are required to disclose potential conflicts of interest by completing the Academy Conflict of Interest Form. It should not be assumed that these financial interests will have an adverse impact on the content, but they are noted here to fully inform readers.

None of the workgroup members listed above disclosed potential conflicts.

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Electronic copies: Available to members from the Academy of Nutrition and Dietetics Web site .

Availability of Companion Documents

The following is available:

- Energy expenditure: measuring resting metabolic rate (RMR) in the healthy and non-critically ill evidence-based nutrition practice guideline. Executive summary of recommendations. Chicago (IL): Academy of Nutrition and Dietetics; 2014. Available from the Academy of Nutrition and Dietetics (AND) Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on January 15, 2015.

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